Surgical treatment of pulmonary artery sarcoma

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Objective: The study objectives were to characterize the prognostic perspectives of pulmonary artery sarcoma and to investigate the effect of distal embolectomy on the prognosis of surgical treatment of pulmonary artery sarcoma.

Methods: Nine patients with pulmonary artery sarcoma were surgically treated at Anzhen Hospital, and the data were retrospectively reviewed. Five patients underwent only pulmonary artery sarcoma resection, and 4 patients underwent both pulmonary artery sarcoma resection and distal embolectomy.

Results: There was no in-hospital mortality. Four patients had lung ischemia-reperfusion injury, 3 of whom recovered with the support of extended ventilation and positive end-expiratory pressure, and 1 of whom recovered with extracorporeal membrane oxygenation support. During the follow-up, 5 patients who did not undergo distal embolectomy died 6 to 29 months after the procedure, with a median survival time of 10 months. Of the 4 patients undergoing distal embolectomy, 3 died 30, 37, and 43 months after the procedure, and 1 is still alive 39 months after the procedure. All 8 deaths were due to local or systemic recurrence. The patients who underwent distal embolectomy lived longer than the patients who did not undergo distal embolectomy (log-rank test, $x^2 = 7.914$, $P = .005$).

Conclusions: Radical surgical resection provides the only chance of survival for patients with pulmonary artery sarcoma, and distal embolectomy may further extend survival for these patients. (J Thorac Cardiovasc Surg 2011;142:1469-72)

Pulmonary artery sarcoma (PAS) is a rare and fatal neoplasm that always arises from the central pulmonary arteries. Early diagnosis and radical surgical resection offer the only chance for survival.[1,2] However, surgical intervention still has some challenges, and the prognosis is poor even after tumor resection.[3] To characterize the prognostic perspectives of the surgical treatment to PAS, we retrospectively reviewed the data of 9 patients with PAS who were admitted and surgically treated at Anzhen Hospital from June 2000 to July 2007.

PATIENTS AND METHODS

The Ethics Committee of Anzhen Hospital approved this retrospective study and waived the need to obtain patient consent for the study. Written informed consent was obtained from each patient before surgery.

Patients

Between June 2000 and July 2007, 9 patients with PAS were surgically treated at Anzhen Hospital. The medical records were retrospectively reviewed to evaluate the clinical characteristics, operative findings, postoperative courses, and long-term results. Patients' mean age was 48.4 ± 9.3 years (range, 35–67 years). Seven patients were female, and 2 patients were male. Most patients presented with syncope (n = 7), cough (n = 6), and dyspnea (n = 9); they also had hemoptysis (n = 4) and chest pain (n = 1), with an average duration of symptoms of 4 months (range, 1–7 months). Six patients had New York Heart Association (NYHA) functional class III, and 3 patients had NYHA functional class IV; the 6-minute walk distance was 289 ± 76 m. One male patient had severe coronary disease, and there were no comorbidities in the other 8 patients. All patients underwent at least 1 or 2 diagnostic tests with pulmonary artery computed tomography angiography (n = 7), magnetic resonance imaging (n = 4), echocardiography (n = 9), or pulmonary angiography (n = 3). Before and 2 weeks after the surgical procedure, all 9 patients underwent pulmonary ventilation/perfusion scintigraphy. On the basis of the findings of the imaging studies, 8 patients had chronic thromboembolic pulmonary hypertension preoperatively. PAS was correctly diagnosed with the aid of positron emission tomography preoperatively in only 1 patient. As shown in Table 1, the histologic and immunochemical findings during or after the surgical procedure in these 9 patients revealed the final diagnosis to be PAS.

Surgical Techniques

All procedures were performed under general anesthesia and approached through a median sternotomy. The first 5 patients (patients 1–5) underwent PAS resection with the aid of moderate hypothermic cardiopulmonary bypass (CPB), during which the pulmonary artery trunk and both the left and right pulmonary arteries were opened, and the PAS was resected via the pulmonary arteriotomy. In addition to the PAS resection, 4 patients (patients 6–9) underwent a further distal embolectomy with the aid of CPB and deep hypothermic circulatory arrest, which included evacuation of both the superimposed thrombosis and the metastasized

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Abbreviations and Acronyms
CPB = cardiopulmonary bypass
NYHA = New York Heart Association
PAS = pulmonary artery sarcoma

PAS embolus in the distal segmental pulmonary arteries. In all patients with a sarcoma tumor that extended from the pulmonary valve to the pulmonary artery trunk, the tumor was carefully peeled from the pulmonary valve and the pulmonary arteries without valve prosthesis replacement or homograft graft replacement. The main body of the PAS was fully resected in all patients. PAS tumor embolus and thromboembolic parts distal to the tumor main body were completely evacuated only in patients 6 to 9, whereas patients 1 to 5 did not receive distal embolectomy. The CPB time was 182.1 ± 35.3 minutes for the whole group, the clamping time for the whole group was 105.1 ± 27.6 minutes, and the circulatory arrest time was 47.7 ± 13.6 minutes for patients 6, 7, 8, and 9.

Postoperative adjuvant treatment included radiation therapy for 2 patients (patients 1 and 7), chemotherapy for 2 patients (patients 5 and 6), and combined radiation and chemotherapy for 3 patients (patients 2, 4, and 8). Two patients (patients 3 and 9) did not receive any adjuvant treatment.

Follow-up

Valid and complete follow-up information was obtained from all 9 patients through postal mail, e-mail, phone interviews, or outpatient department visit. Screening by magnetic resonance imaging, pulmonary artery computed tomography angiography, and echocardiography was performed in all patients every 3 months after PAS resection. The last follow-up for the surviving patients was as late as October 2010.

Statistical Analysis

All statistical analyses were performed with SAS for Windows Version 8.2 (SAS Institute, Inc, Cary, NC). Categoric data are presented as total numbers and relative frequencies. Continuous data are presented as mean ± standard deviation. Comparisons between the 2 groups (with or without distal embolectomy) were made using the log-rank test as appropriate.

RESULTS

Early Results

There was no in-hospital mortality. After the PAS resection procedure, 4 patients had pulmonary ischemia–reperfusion injury, 1 of whom required extracorporeal membrane oxygenation as life support. Extracorporeal membrane oxygenation was weaned 23 hours after installation, and the patient was extubated 70 hours after the procedure. The other 3 patients recovered through extended mechanical ventilation and positive end-expiratory pressure support. The mean length of intensive care unit stay after operation was 48.7 ± 25.8 hours (range, 27–74 hours). The mean length of hospital stay after operation was 18.7 ± 8.8 days (range, 10–29 days). One month after the operations, the heart function of all patients improved from NYHA functional class III or IV preoperatively to NYHA functional class I, and the 6-minute walk distance increased from 289 ± 76 m preoperatively to 425 ± 85 m ($P = .0001$). The results of the pulmonary ventilation/perfusion scintigraphy before and 2 weeks after the surgical procedure are shown in Table 2.

Pathologic Findings

The resected specimens were divided into 3 parts: the main body of the tumor (Figure 1, *A*), the metastasized PAS embolus in the distal segmental pulmonary artery (Figure 1, *B*), and the superimposed thromboembolism distal to the PAS (Figure 1, *C*). The main body of the tumor was a gray-white firm gelatinous polypoidal mass, 6 to 10 cm in length, and 3.5 to 5 cm in width. The tumor specimens of 7 patients took the shape of the main pulmonary artery and extended to the segmental pulmonary artery, adhering to the vascular wall and pulmonary valve. Macroscopic examination of the resected specimen showed a gelatinous, polypoid mass. The diagnosis and histologic classification were made by the reference pathologists in Beijing Anzhen Hospital. Pathologists performed the immunohistochemistry staining according to published protocols,[4,5] with antibodies against muscular actin, vimentin, h-caldesmon, CD34, CD117, S-100, smooth muscle actin, desmin, and CD68. Histologic and immunohistochemical diagnoses of the 9 patients are shown in Table 1.

Late Results

As Table 3 shows, the 5 patients (patients 1–5) not receiving distal embolectomy died 6 to 29 months after tumor

TABLE 1. Clinical characteristics and pathologic findings of patients with pulmonary artery sarcoma

Patient no.	Age/sex	Initial diagnosis	Histologic subclassification	Size (cm), length × diameter	Origin of tumor
1	35/F	CTEPH	Leiomyosarcoma	8 × 5	Right pulmonary artery
2	39/F	CTEPH	Undifferentiated sarcomas	7 × 4.5	Pulmonary trunk
3	43/M	CTEPH	Pleomorphic rhabdosarcoma	8 × 4.5	Pulmonary trunk
4	54/F	CTEPH	Intimal sarcoma	7 × 5	Pulmonary trunk
5	52/F	CTEPH	Intimal sarcoma	10 × 4.5	Pulmonary trunk
6	50/F	CTEPH	Leiomyosarcoma	9 × 3.5	Right pulmonary artery
7	47/M	CTEPH	Intimal sarcoma	6 × 3	Pulmonary trunk
8	49/F	CTEPH	Intimal sarcoma	8.5 × 4.5	Pulmonary trunk
9	67/F	PAS	Intimal sarcoma	9 × 4.5	Pulmonary trunk

CTEPH, Chronic thromboembolic pulmonary hypertension; *PAS,* pulmonary artery sarcoma.

TABLE 2. Comparison of residual occluded pulmonary segment as scanned with pulmonary ventilation/perfusion scintigraphy before and 2 weeks postprocedure

	PAS resection with distal embolectomy (n = 4)		PAS resection without distal embolectomy (n = 5)		
	Preoperative	Postoperative	Preoperative	Postoperative	*P*(t)
Ventilation/perfusion scintigraphy	15 ± 1.83	2.0 ± 0.82	14.6 ± 1.52	4.8 ± 1.3	.7294* (0.3600)
P(t)	.0001 (12.9655)		0.0001 (10.9562)		.0074† (3.7227)

*P value for the t test before the procedure between the 2 groups. †P value for the t test 2 weeks postprocedure between the 2 groups.

resection, with a median survival of 10 months (mean, 12. 6 ± 8. 3 months). Among the 4 patients who received distal embolectomy, 3 died 30, 37, and 43 months after the procedure, and 1 is still alive 39 months after the procedure. The patients who received distal embolectomy are surviving longer than those without distal embolectomy (log-rank test, $x^2 = 7.914$, $P = .005$). The causes of 8 deaths were all related to the recurrence of PAS. The pattern of recurrence was local recurrence in 4 patients (patients 1, 3, 4, and 6) and distant metastasis in 6 patients (patients 2, 4, 5, 6, 7, and 8). The site of metastasis was lung in 5 patients (patients 3, 4, 5, 6, and 8), brain in 1 patient (patient 2), bone in 1 patient (patient 4), liver in 3 patients (patients 4, 6, and 7), and right thorax wall in 1 patient (patient 1).

DISCUSSION

PAS is a rare tumor, and only a few hundred cases have been reported in the literature.[6,7] Because the clinical symptoms of patients with PAS are often insidious and nonspecific, it is difficult to make an early diagnosis of this uncommon disease.[8] Therefore, PAS is usually detected at an advanced stage, which renders curative resection nearly impossible.[9] The prognosis of PAS is extremely poor. The natural course of the disease is determined by local tumor growth and additional superimposed thrombosis and metastasized tumor emboli, both of which lead to progressive obstruction of the pulmonary vessels.[10] The median survival of untreated patients is as short as 1.5 months (range, 1.5–5.5 months),[11,12] with decompensate heart failure as the primary cause of death.[13] Surgery remains the mainstay of treatment for PAS because early radical resection offers the only chance for a potential cure. Treatment with aggressive resection lengthens the median survival time to 10 months, with rare reports of patients remaining tumor-free 5 years after the initial surgery.[14] Bacha and colleagues[15] retrospectively analyzed 23 patients with PAS who underwent surgical therapy. The actuarial 3- and 5-year survivals of the resected patients were both 69%. They concluded that a resection of the primary PAS could produce an acceptable survival if the resection was complete.

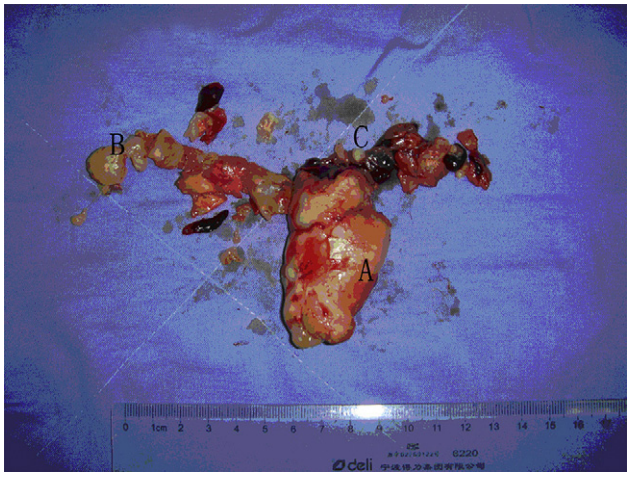

FIGURE 1. Resected specimen from patient 9. A, Main body of the PAS. B, Metastasized PAS embolus in the distal segmental pulmonary arteries. C, Superimposed thrombosis.

The surgical interventions include ‘‘shelling out’’ the tumor concomitant with pulmonary artery thromboendarterectomy, pneumonectomy with or without CPB support, and extended resection with major reconstruction.[16] Many tumors are not completely resectable at the time of the diagnosis, and palliative surgery plus thromboendarterectomy may be the only option. Even with surgical therapy, the prognosis is poor. Complete resection remains the main factor affecting survival in patients after resection. Because of the difficulty of distal pulmonary segment embolectomy or unawareness of its importance, most cardiac surgeons perform only a PAS resection without distal pulmonary embolectomy, leaving the superimposed thrombosis and metastasized PAS emboli in the distal segmental pulmonary arteries unattended. As Table 2 shows, the pulmonary ventilation/perfusion scintigraphy scanned 2 weeks after the resection procedure revealed that distal embolectomy may further evacuate the distal pulmonary emboli, thus reducing the probability of residual occlusion of the pulmonary segments.

Currently, the best results are obtained with the resection of the tumor and its implantation site, followed by reconstruction of the main pulmonary artery with a pericardium homograft.[17] Associated pneumonectomy has not shown survival benefit in the small series analyzed retrospectively. Concomitant chemotherapy and radiotherapy seem to

TABLE 3. Operative procedures and postoperative outcomes of patients with pulmonary artery sarcoma

Patient No.	Operative procedure	Adjuvant treatment	Recurrence	Outcomes
1	PAS resection	Radiation therapy	Yes, right thorax	Died at 6 mo
2	PAS resection	Chemoradiation therapy	Yes, brain	Died at 11 mo
3	PAS resection	No	Yes, lung	Died at 7 mo
4	PAS resection	Chemoradiation therapy	Yes, liver, lung, adrenal gland, bone	Died at 10 mo
5	PAS resection	Chemotherapy	No	Died at 29 mo
6	PAS resection + distal embolectomy	Chemotherapy	Yes lung, liver	Died at 43 mo
7	PAS resection + distal embolectomy + CABG	Radiation therapy	No	Died at 30 mo
8	PAS resection + distal embolectomy	Chemoradiation therapy	No	Died at 37 mo
9	PAS resection + distal embolectomy	No	No	Alive at 39 mo

PAS, Pulmonary artery sarcoma; *CABG,* coronary artery bypass graft. Distal embolectomy includes the evacuation of the superimposed thrombosis and metastasized PAS embolus in the distal segmental pulmonary artery branches.

improve midterm survival (1–2 years). As Figure 1 shows, appositional thrombosis covering the tumor in the distal or proximal part of PAS may complicate the diagnosis and therapeutics of the PAS. The superimposed thrombosis and metastasized PAS emboli in the distal segmental pulmonary arteries could only be evacuated with embolectomy distal to the PAS. Our data suggest that embolectomy distal to the PAS may further extend patient survival. According to Blackmon and Reardon,[18] future approaches in treating this deadly disease will include better biologic treatments with possible ''maintenance'' chemotherapy, complete cardiac excision and replacement with a mechanical device to enable radical resection, and use of cardiotoxic chemotherapy without penalty. Distal embolectomy is an effort to approach complete cardiac excision of PAS, so we think it is worth further study for its survival benefits to patients with PAS.

Study Limitations

This study is a retrospective analysis of a small case series; therefore, some confounding factors may be involved to show a significant association between prognosis and distal embolectomy. The small number of patients made statistical validity meaningless, so the results from this study are preliminary and not conclusive. More case reports or series reports for this rare entity would allow us to reduce potential bias. Despite this limitation, our findings provide suggestions for inclusion of distal embolectomy in the surgical procedure as a future direction for treatment of PAS.

CONCLUSIONS

Radical surgical resection provides the only chance of survival for patients with pulmonary artery sarcoma, and distal embolectomy may further extend survival for these patients.

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